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### The Material Sociology of Arbitrage

**Citation for published version:**

Hardie, I & MacKenzie, D 2012, The Material Sociology of Arbitrage. in K Knorr Cetina & A Preda (eds), *The Oxford Handbook of the Sociology of Finance: Oxford Handbooks in Business and Management*. Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780199590162.013.0011>

**Digital Object Identifier (DOI):**

[10.1093/oxfordhb/9780199590162.013.0011](https://doi.org/10.1093/oxfordhb/9780199590162.013.0011)

**Link:**

[Link to publication record in Edinburgh Research Explorer](#)

**Document Version:**

Peer reviewed version

**Published In:**

The Oxford Handbook of the Sociology of Finance

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# The Material Sociology of Arbitrage

Iain Hardie and Donald MacKenzie

“Arbitrage” is a term with different meanings, but this chapter follows market practitioners in defining it as trading that aims to make low-risk profits by exploiting discrepancies in the price of the same asset or in the relative prices of similar assets. A classic example historically was gold arbitrage. If the price of gold in Saudi Arabia exceeds its price in New York by more than the cost of transportation, arbitrageurs can profit by buying gold in New York and selling it in Saudi Arabia (or vice versa if gold is cheaper in Saudi Arabia). By buying and selling as close to simultaneously as possible, arbitrageurs avoid the risks of “directional” trading: they profit irrespective of whether the price of gold goes on to rise or to fall.

Arbitrage requires technological resources, sustained effort, and expertise beyond the capacity of nearly all lay investors. It is the preserve of market professionals, and is a crucial form of trading. Arbitrage constitutes markets, for example helping to determine their scope and the extent to which they are global; that international gold arbitrage is possible creates a world market in gold with a “world price,” rather than geographically separate markets with different prices.

In constituting markets, arbitrage has wider consequences for economies and political systems. For example, in the late 1990s arbitrageurs in hedge funds and investment banks began to perceive growing similarity between the bonds issued by the government of Italy and those issued by other European countries, notably Germany. For a variety of reasons (including distrust of the fiscal efficiency of the Italian state and consequent fears of it defaulting on its bonds), the prices of Italian government bonds had traditionally been low relative to those of

countries such as Germany, thus imposing high debt-service charges on Italy. As arbitrageurs began to buy Italian bonds, their relative prices rose and the proportion of Italy's government expenditure devoted to debt service fell. The process—which was assisted by the liquidity created by the MTS electronic bond-trading system, set up by the Italian treasury in 1988—helped Italy meet the Maastricht criteria for the European Economic and Monetary Union (EMU). Arbitrageurs' beliefs thus had a self-validating aspect—they prompted trading that made the event (Italy's qualification for EMU) on which the beliefs were predicated more likely—and helped to create a European government bond market, rather than separate national markets, although the Greek crisis in 2010 caused those markets once again to diverge radically.

The failures of arbitrage can be as consequential as its successes. Such failures were at the heart of three of the most serious crises of the postwar financial system: the 1987 stock market crash, the 1998 turmoil surrounding the hedge fund Long-Term Capital Management (LTCM), and the 2007–8 credit crisis. A crucial aspect of the 1987 crash was the breakdown of the link—normally imposed by arbitrage—between the stock market and a key derivatives market: stock-index futures. In the case of LTCM, the forced unwinding of arbitrage positions caused huge, sudden, highly correlated price movements across the globe in apparently unrelated assets, bringing some markets close to paralysis. Arbitrage was the crucial motivation for the creation of the structured financial instruments at the heart of the credit crisis.

There is an enormous disciplinary imbalance in regard to arbitrage. It has received almost no sustained attention in economic sociology, in economic anthropology, in economic geography, or in the strand of political science known as international political economy, even in the subsets of those specialties that deal with financial markets (the limited exceptions include Beunza and Stark 2004; Hardie 2004; MacKenzie 2003; Miyazaki 2003; Robotti n.d.; and Stark 2009). In

contrast, the central theoretical mechanism invoked by modern financial economics is “arbitrage proof.” The field posits that the only patterns of prices that can be stable are those that permit no opportunities for arbitrage. Particular patterns of prices are then shown to be necessary by demonstrating that if prices deviate from that pattern arbitrage is possible. Arbitrageurs’ purchases of “underpriced” assets will raise their prices, and their sales of “overpriced” assets will lower the prices of the latter, so returning patterns of prices to that stable condition. The entire modern theory of asset pricing—especially the theory of the pricing of derivatives such as options—relies on “arbitrage proof” of this kind.

The conceptualization of “arbitrage” in mainstream financial economics differs from the arbitrage as market practice that is the focus of this chapter. Orthodox economists define arbitrage as demanding no capital and involving no risk, while in market practice arbitrage seems always to require some capital and involve some risk, even if the risk is only that a counterparty to a transaction will not fulfill its obligations (Hardie 2004). Indeed, a purist would argue that the trading we consider in this chapter should not be considered “arbitrage” but simply “relative value” trading.

Purism, however, has its costs—a purist definition of “arbitrage” excludes the real-world counterparts of the canonical arbitrages of finance theory (see MacKenzie 2006)—and purism is not the only possible response. Financial economists—especially “behavioral” economists—have begun to investigate the consequences of making the definition of arbitrage more realistic (a crucial article in this respect was by Shleifer and Vishny 1997). These economists rightly see the topic as a crucial one. Since, in orthodox views, it is, above all, arbitrage that makes markets efficient, the existence of limits to arbitrage casts into doubt the full validity of the central tenet of modern financial economics: the efficient market hypothesis, according to which prices in

mature capital markets fully reflect, effectively instantaneously, all available price-relevant information.

We shall suggest below that there are potentially productive linkages between the emerging literature in economics on the limits of arbitrage and the “material sociology” of arbitrage that we advocate. Material sociology pays attention to, among other things, the role played in social relations by technological systems and other physical objects and entities, including human bodies viewed as material entities: see MacKenzie (2009a). Since

that role is, of course, pervasive, all sociology should be material sociology, yet social theory frequently abstracts away from physical objects and empirical enquiry often does not focus on them. As we shall argue, a proper understanding of arbitrage requires us to take into account both its “physical” and “social” aspects, and the two are ultimately inseparable: arbitrage is *simultaneously* a “physical” and a “social” process.

## **Brazil 14s and 40s**

We begin with a concrete example of arbitrage. January 5, 2005: the authors are observing trading in a small London hedge fund, when one of its managers notices an oddity in the Brazilian government bond market.<sup>2</sup> The minutes of the US Federal Reserve’s Open Market Committee, released the previous evening in London time, have been taken by market participants as indicating that interest rate rises are on the way, and have led to general price falls in the Brazilian bond market. However, the “14s” (an issue of dollar-denominated bonds that mature in 2014) are “trading up”: their price is high relative to other bonds. “Hit the bid” (sell them), the manager suggests to his colleague, the fund’s trader.

The trader does not respond immediately, but he goes on to ask his assistant to produce a chart of the prices over the last three months of the “14s” and the “40s” (Brazilian government dollar-denominated bonds that mature in November 2040). As the day proceeds, the trader takes a position in the 14s and the 40s, short selling the former and buying the latter. (To “short sell” an asset is to sell it without owning it, for example in the hope that it can be bought at a lower price when the time comes to deliver it.) He also sends a contact in an investment bank the Excel file containing the price chart produced by his assistant, encouraging his contact to circulate it to others. (Later in this chapter we discuss why he does this.)

A bond maturing in 2040 seems very different from one maturing in 2014: much could happen in the quarter century between the two dates. But the bond maturing in 2040 is “callable”: the Brazilian government has the right to recall the bond by repaying the principal early, in 2015. If Brazilian bonds continue to trade at anything like their current prices, it will be in the government’s interest to do this, since it will be able to replace the borrowing more cheaply. The “40s” thus in effect mature in 2015 and so, despite appearances, a “14” and a “40” are quite similar.

None of this is said explicitly: it is part of what all sophisticated participants in the Brazilian bond market simply “know.” (Hardie was an investment banker before returning to academia, and was involved in the initial sale of the “40s” on behalf of the government of Brazil, so he knows it too, though he needs to whisper an explanation to MacKenzie.) Nevertheless, the chart produced by the trader’s assistant is a material representation that makes visible the reasoning underpinning the trade. Once he has configured the chart according to the trader’s wishes—initially, it shows the prices of the 14s and the prices of the 40s, when the trader wants it to display the difference in prices—the prices of the two bonds can be seen to follow each other

closely, as would be expected, but with the 40s almost always slightly more expensive than the 14s. Again, the reason is common knowledge among aficionados. The 40s are the most liquid of Brazilian government bonds, the ones most readily bought and sold, and thus the most attractive to those who wish to create and to exit positions quickly.

Someone viewing the chart can see what the trader has seen: in recent days the 14s have become more expensive than the 40s, with the difference increasing sharply the previous day (January 4). The trader knows his market well enough to infer a cause that is confirmed only later in the day in a telephone conversation with the above-mentioned investment bank contact. The sell-off triggered by US Federal Reserve's minutes has concentrated in Brazil's liquid 40s. Indeed, as the contact tells the trader, unusually "the real money guys [traders not in hedge funds but in bigger institutions] shorted 40s."

The trader thus confidently assumes—and makes explicit in a telephone conversation with his contact—that the fact that 14s are more expensive than 40s is a price discrepancy that will be temporary. By short selling 14s and buying 40s, he—and indeed others—can perform an arbitrage (in market practitioners' sense of the term). The discrepancy would be expected to vanish in the normal course of events, but if others choose also to exploit it (perhaps because the investment bank contact circulates the assistant's chart to them), the process will be hastened, maybe considerably. By early afternoon, the trader has accumulated some \$13 million of short sales of 14s and another \$13 million of purchases of 40s. By mid-afternoon, he is able to say "it's moved in my favor"—the discrepancy has started to reduce—"but not enough to unwind": he keeps the position on, expecting further reductions in the discrepancy. Only at the end of the week does he liquidate his position, earning a healthy profit.

Note what the trader is not doing in this trade. Like the gold arbitrageur, he is not taking a “directional” view. He is not attempting to predict the policies of the Brazilian government, to estimate the probability of bond default by Brazil, or to anticipate the future courses of interest rates or inflation: because the 14s and the 40s are so similar, changes in factors such as these will affect the prices of each bond roughly equally, and with the trader’s matched “long” and “short” positions the effects will cancel out. As the trader puts it in a telephone call to his contact in the investment bank, “there is zero market risk” in the trade: its profitability (“there is at least half a point in that trade”) should not be affected by overall rises and falls in the prices of Brazilian government bonds. In fact, as he acknowledges to us, the trader’s position is not entirely free from risk—see below—but, in its insulation from the major risk factors in his market, it is low risk.

Asked about the rationale of the trade, the trader says (just as a financial economist would) that the fact “that this trade has presented [itself] indicates [an] inefficiency.” Temporarily, prices are reflecting something other than information such as the relative liquidity of the two bonds. Although the trader’s motivation may simply be to earn money for his hedge fund, his actions are helping to eliminate a discrepancy and correct the effects of an “inefficiency.” In that respect, his trading, even if not free of risk, resembles arbitrage as conceived by financial economics.

## **The Materiality of Arbitrage**

A price is a thing. Like all prices, those to which the trader was responding (and circulating in the form of the chart prepared by his assistant) were physical entities—patterns on computer screens and spoken numbers transmitted by telephone. The forms of embodiment of prices are various—the sound waves that constitute speech; pen or pencil marks on paper; the electrical



impulses that represent binary digits in a computerized system or encode sound over a telephone line; hand signals in “open-outcry” trading pits that are too noisy for voices to be heard; and so on—but are always material. If a price is to be communicated from one human being to another, or from one computerized trading system to another, it must take a physical form.

The materiality of prices matters to arbitrage because their physical embodiment affects the extent and speed of their transmission. Classical forms of arbitrage exploited the differences between prices in different places. The commodities and currency arbitrageur J. Aron & Company, for example, used to keep telephone lines to Saudi Arabia open constantly so it could, as quickly as possible, detect and exploit the emergence of discrepancies in gold or silver prices (Rubin and Weisberg 2003: 90–1).

The development of electronic price dissemination systems (such as the “Monitor” system, introduced by Reuters in 1973: see Knorr Cetina and Bruegger 2002) largely undermined the time–space advantages that firms such as Aron had achieved by the use of social networks, the telegraph, and telephone. Electronic price dissemination does not, however, entirely eliminate differences in the speed of transmission of prices, and those differences remain consequential, even if they are now measured in milliseconds or even microseconds. An “arms race” has been underway for some time among arbitrageurs, and also those using automated order-placing systems to optimize their trading in other ways, in respect to transmission delays in computer networks. For example, firms are prepared to pay a premium to have their computer systems physically close to an exchange’s computer system. The end of face-to-face trading on exchange floors has meant that the human bodies participating in such trading need no longer be located in one place, but a recentralization of technological systems is running alongside the decentralization of bodies.

Arbitrage often involves bodily skills. Concluding a transaction over the telephone with one party to buy gold, a currency, or other asset, while at the same time telling a colleague to sell it to another party at a higher price is unlikely to succeed if one's conversation with the colleague can be heard. It is thus important in this (and in many other uses of the telephone in financial markets) that one switches off the microphone when talking to colleagues. The telephones used in dealing rooms often have thumb-operated switches behind the earpiece that make it easy to do this, and many people always switch off the microphone when the party at the other end of the line is speaking, even if there is no parallel conversation for them to overhear. That way, it becomes a bodily habit that will not desert one in situations of excitement or stress.

Even electronically conducted arbitrage can also involve material, embodied skill. Such trading involves placing "bids" (offers to buy) or "asks" (offers to sell) for the asset in question. This is generally done by using a computer mouse to click on a screen that, at least in the case of electronically traded futures, shows for each price level the numbers of bids (often in blue) and of asks (often in red). At busy times, these numbers and levels change from second to second, with blue and red bars seeming to dance up and down. If an arbitrage opportunity persists only for seconds (as is often the case), constant attention and rapid physical execution are needed. The anthropologist Caitlin Zaloom reports that as trainee futures traders she and her colleagues were made to practice repeatedly with a computerized gold-price arbitrage simulation, so that the disciplined attention and fast, accurate action they would need became bodily habits. As Zaloom says, they were encouraged "to play commercial video games on our own time to increase our reaction speeds and hand-eye coordination." A particular danger they were trained to avoid was "fat fingering," in which, for example, instead of left-clicking the mouse to "join the bid" (putting in an offer to buy at a set price) they accidentally right-clicked, inadvertently buying the

asset in question at its current market price. The managers' aim was to "train our bodies to operate as uninterrupted conduits between the dealing room and the on-line world, allowing our fingers to become seamless extensions of our economic intentions" (Zaloom, personal communication; see Zaloom 2006).

The bodily aspects of arbitrage were most prominent when it was performed in open-outcry trading "pits": stepped amphitheaters, which were traditionally octagonal. Dozens or hundreds of traders stood on the rungs of a pit, making deals by voice or by eye contact and an elaborate system of hand signals. In Chicago (the prime site of open-outcry trading), the hand-signal language that was used was called "arb" because its speed was essential to arbitrage. For example, when a trading firm spotted an arbitrage opportunity, canonically between the prices of gold futures traded in Chicago and in New York, it was quicker to "arb" (hand-signal) instructions from the firm's booth to the trading pit than to send a clerk running to the pit with a written order (Lynn 2004: 57–9; see also Zaloom 2006).

Where bodies are positioned with respect to each other could be of considerable significance to arbitrage in open-outcry trading. For example, the two main forms of option are calls (options to buy at a set "exercise price") and puts (options to sell at a set price), and discrepancies between call and put prices can be exploited by arbitrages such as "conversion." (In conversion, a trader sells a call option and simultaneously buys a put option with the same exercise price and expiration plus the stock or other underlying asset in question.) Options arbitrageurs on the American Stock Exchange found it advantageous to stand in between the "specialist" (designated main trader) responsible for calls and the specialist responsible for puts on the same stock. That was the optimum bodily position for detecting and exploiting opportunities for conversion and similar arbitrages.

# The Sociality of Arbitrage

A price is a thing, but it is also social. All forms of arbitrage depend for their success on what others will do. Even in the classic forms of arbitrage that exploit differences in the prices of the “same” asset in different places, others must be depended upon to fulfill their obligations: for example, to deliver gold if the arbitrageur has struck a deal to buy it, or to deliver money if the arbitrageur has sold gold. Procedures carried out by others must also be relied upon to ensure that gold in Riyadh is “the same” as gold in Manhattan. Others yet again may be needed to transport gold from one place to another. (When securities were paper certificates, their transportation from place to place and the risk of loss of them during such transportation were issues that arbitrageurs had to consider.)

The “sameness” of gold is established by assay procedures “external” to the market that can be treated by market practitioners as a “black box”—a reliable process whose details they do not need to consider—and nowadays “transportation” of securities is also usually treated by traders as a black-box matter. However, many—probably most—current forms of arbitrage exploit discrepancies in the prices not of the “same” asset but of “similar” assets: Brazil 14s and 40s; stocks and stock-index futures; stocks and options on those stocks; Italian and German government bonds; newly issued (“on-the-run”) government bonds and previously issued (“off-the-run”) bonds; government bonds and bonds carrying implicit government guarantees but backed by pools of mortgages; the shares of the two legally distinct but economically integrated corporations that until 2005 made up the Royal Dutch-Shell group; and so on. However, the similarity of assets such as the Brazil 14s and 40s, or of shares in Royal Dutch and in Shell, depends, at least over the short and medium term, on others within the market treating them as similar, and the arbitrageur can seldom afford to treat this as a black box.

The “similarity” of financial assets is always in a sense theory-dependent. Sometimes, the theory in question is a sophisticated mathematical model. At other times, the theory is vernacular and down-to-earth: for example, that the 40s will remain Brazil’s most liquid government bonds, or that the intended Eurozone would converge, making Italian bonds similar to German bonds. To embark upon arbitrage, traders thus have to convince themselves that the theory on which the arbitrage rests is correct, or at least plausible enough to be the basis of practical action. They will often also want to or need to convince others. In our observations of the hedge fund (and the observations of an investment-bank arbitrage trading room by Beunza and Stark 2004) there was much discussion of possible trades and of the theories underlying them, both inside the organization and in the form of analyses coming in from outside (and occasionally flowing in the opposite direction). Critical roles in these discussions are often played by material representations of value, such as the chart showing the recent history of the difference in prices between the 40s and the 14s, or a “spread plot,” showing the relative prices of Hewlett Packard and Compaq, which Beunza observed being closely followed in 2001–2 by “risk arbitrageurs” hoping to exploit the probable—but not certain—merger between the two corporations (Beunza and Muniesa 2005). But material representations are often not on their own conclusive: information about what other traders are doing—for instance, about the behavior of “real money” in the Brazilian bond market—can also be important in allowing the plausibility of theories to be judged.

The need to convince others does not necessarily cease once a trader takes on an arbitrage position. Often, the price discrepancy that is being exploited will increase further before it decreases, which means that the arbitrageur will incur apparent losses. Sometimes, apparent losses are actual outflows of money or securities (or, at least, the electronic traces thereof), for

example as a result of the daily process in which exchange clearing houses adjust the “margin” deposits that participants must maintain in order to be allowed to continue to hold their positions. At other times, there are no actual outflows, but as banks and hedge funds “mark to market” (revalue their trading positions, which is now also normally done at least daily), a position shows a loss. In either case, the losses will be temporary (the outflow will be replaced by an inflow, a “paper” loss will turn into a realizable profit) if the theory underpinning the arbitrage is correct, but others may need to be convinced of this to allow the arbitrageur to continue holding the position.

In a large institution such as a bank, the immediately important audience for arbitrage is an arbitrageur’s manager or managers, who will normally be closely attentive to the “P&L” (profit and loss) figures of those they supervise. “There’s a saying in trading circles,” one trader and manager told us: “the white sheet [P&L sheet] doesn’t lie”—losses are real, and should be acted upon as if they are real. The arbitrageur’s problem, however, is that from his or her viewpoint the white sheet does often lie, at least temporarily. A common complaint among arbitrageurs is of being instructed by managers to liquidate loss-bearing positions that they were certain would become profitable. Even “textbook” arbitrages can be subject to this risk: the traders in the Japanese securities firm studied by Miyazaki (2003) reported being forced to abandon arbitrages between stocks and stock-index futures because of the apparent losses incurred when they had to deposit additional futures margin. Such management behavior may seem incomprehensible until one realizes that the boundary between arbitrage and speculation is porous, and it can be hard for managers to be certain that arbitrageurs have not in fact started to speculate on the rise or fall of prices. Two of the most celebrated “rogue traders”—Nick Leeson of Barings Bank and Jérôme

Kerviel of Société Générale—were arbitrageurs who covertly became very large-scale speculators.

In hedge funds, the manager/arbitrageur divide is typically much less marked: even in large funds such as LTCM the two roles are not distinct. Investors, however, form a more immediate audience than they do in the case of banks. Hedge funds report changes in net asset values to their investors monthly, while banks report quarterly or less frequently (depending on the jurisdiction in which they are incorporated), and losses in a hedge fund's trading are not masked by the profitability of other lines of business as they often are in banks. So a large loss by a hedge fund conducting arbitrage—even a “paper” loss—quickly becomes visible. One hedge fund manager (and former investment banker) told us that in a bank “you can justify why you want to hold on to those positions,” while hedge fund investors “don’t care. They just look at the number [change in net asset value].” The threat of investors withdrawing their capital from the fund is thus almost continuous: “there is very small tolerance to losing money. ... [W]e cannot have a losing month.”

The risk of arbitrageurs in a bank having to abandon their positions because of temporary losses is reduced if managers understand and accept the theory underpinning a trade, and thus believe that losses will indeed be temporary. One advantage of investment banks with long experience of arbitrage over newcomers such as the Japanese firm studied by Miyazaki is that this understanding is much more likely. Often, though, the technical details of arbitrage trading are daunting even to those with extensive market experience. In such cases, trust in arbitrage in practice often has to be trust in the arbitrageur or arbitrageurs as particular people, just as in many cases trust in science comes down to trust in the scientist (see Shapin 1994). A hedge fund, a university endowment manager, or an individual trader or trading desk at a bank who or which

has built up a good reputation is more likely to be trusted. LTCM's founder John W. Meriwether had led Wall Street's premier arbitrage desk (at Salomon Brothers), and his colleagues included other traders with high personal reputations. They were able to have LTCM's investors accept a three-year "lock-in" in which they were not allowed to withdraw capital, and even after the near bankruptcy in 1998 they successfully recruited investors to a successor fund, JWM Partners.

Losses, even temporary, can, in addition, be avoided if other arbitrageurs and professional traders also come to view the price difference that an arbitrageur is exploiting as a discrepancy. In our hedge-fund observations, for example, we were struck by the extent of the circulation among traders in different funds and banks, mainly by electronic mail, of ideas for trading; and in wider interviews with professional traders we have found almost all pay much attention to what others seem to be doing. If that discussion and attention leads others also to seek to exploit a discrepancy, then their purchases and sales will narrow the discrepancy, or at least reduce the risk of it widening. That, for example, was why the trader discussed in this chapter's second section wanted the chart displaying the 14s/40s anomaly circulated to others. "All I want is people even to talk about it," the trader told us. If others also took action on the pricing anomaly, they would prevent it widening. Should it widen, the trader explained, he might even come to doubt his belief (the "theory" behind the trade) that the anomaly was a discrepancy that would close. "There might be a reason [for the anomaly] I don't understand. I might have to reconsider the decision [to construct a trading position predicated on it narrowing]."

Another way of minimizing the risk of premature capital withdrawal is diversification. If a fund, trading desk, or bank holds a wide variety of arbitrage positions—for example, in different parts of the world and in different asset classes—then, on the face of it, there is little likelihood of enough of those positions losing money simultaneously to create a serious overall loss. (The



matched “long” and “short” positions characteristic of arbitrage mean that common factors such as global economic conditions, the levels of interest rates, and the buoyancy of stock markets should have little or no effect.) Diversification of this kind was, for instance, a core aspect of LTCM’s strategy.

However, the constant attention of many professional traders to what others are doing may undercut the benefits of diversification. If large numbers of traders are led all to take similar positions, then arbitrages that “ought” to be uncorrelated can suddenly become linked. This, for example, was what caused LTCM’s diversification to fail. LTCM tried hard to keep its positions private: as a very large market participant with a largely locked-in capital base, it was concerned less with the benefits of others preventing discrepancies widening than with their trading causing the opportunities it was exploiting to diminish or vanish. However, others did frequently take on similar positions, either because they were following the same general strategy (in part in emulation of LTCM’s success) or because they learned specifics of LTCM’s trading from those who took the other side of those trades. “I can’t believe how many times I was told to do a trade because the boys at Long-Term deemed it a winner,” says one hedge fund manager (Cramer 2002: 179).

The resultant overlapping set of arbitrage positions made it possible for an event to which LTCM itself had only a limited exposure—the Russian government’s default on its rouble-denominated bonds on August 17, 1998—to cause sudden, highly correlated, adverse price movements across the globe and in apparently unrelated asset classes. Arbitrageurs who incurred losses in Russia had to liquidate positions (even in apparently unrelated assets) to meet margin calls, withdrawals by investors, and other demands on their capital. In aggregate, the positions they sought to liquidate overlapped considerably with each other and with LTCM’s portfolio.

These liquidations in turn caused more losses, leading to further liquidations, and so on in a disastrous, market-paralysing spiral.

The sociality of arbitrage goes beyond relations to particular others such as managers, hedge fund investors, and other arbitrageurs: the conduct of arbitrage is affected deeply by the forms of action in financial markets that are seen as permissible and to be encouraged or as impermissible and to be discouraged. One persistent issue is the difference in this respect between the two standard “legs” of an arbitrage trade. Typically, a price discrepancy is exploited by buying (or in other ways taking a “long” position in) an undervalued asset, and short selling a similar overvalued counterpart.

Long positions are almost always regarded as unproblematic, but short positions have historically often been the object of suspicion. Short sellers are frequently blamed for falls in price, and the activity is seen as morally reprehensible for other reasons: for instance, in current interpretations, borrowing securities in order to short sell them is contrary to Sharia, creating a problem for those who wish to set up “Islamic” hedge funds. In some markets (for example, Mexican government bonds) only specific, trusted market participants are allowed by regulators to sell short. In other markets short selling by a wide range of participants is permitted but is constrained in other ways. Until 2007, for example, short sales of stock in the US were subject to the “uptick rule” (see, for example, Robotti n.d.)—they were prohibited unless the last price change had been upwards—which could cause substantial delays in short selling if prices are falling consistently. Because the extent of the problems of short selling varies from asset to asset, systematic effects of these problems can be detected. Thus Dow Jones futures and other stock-index futures seem to tend more often to be below the value implied by the level of underlying index than above it (Shalen n.d.). The trading required to exploit “overpricing” of futures is

straightforward: the arbitrageur has to establish a short position in futures (which means simply selling futures, and involves no particular difficulties), while buying the stocks that make up the index (also straightforward). In contrast, exploiting “underpricing” of futures requires the arbitrageur to buy futures (again straightforward), but it also involves short selling the underlying stocks, which is, as noted, often more problematic.

## **Arbitrage and the Credit Crisis**

Arbitrage played a central role in the genesis of the credit crisis that erupted in the summer of 2007 and culminated in the near-collapse of the global banking system in autumn 2008. At the core of the crisis were two classes of structured security: asset-backed securities (ABSs) and collateralized debt obligations (CDOs). The constructor of an ABS or CDO sets up a legal vehicle (a trust or special purpose corporation), which buys a pool of mortgages or other forms of consumer debt (in the case of ABSs) or of corporate debt in the case of the original CDOs. (An important category of CDO known as ABS CDOs bought ABSs rather than corporate debts for their pool.) The money needed for this special purpose vehicle to buy the debt for its pool was raised by selling to investors securities that were claims on the cash flow generated by the debt. Those claims were “tranching”: the holders of the topmost tranche (“senior” or sometimes “super-senior”) had the first claim on the cash flows from the pool, which meant that this tranche was the safest. The holders of intermediate tranches (referred to as “mezzanine”) were next to have their claims met. At the bottom of the hierarchy was a tranche (known as the “first-loss piece” in the case of ABSs and “equity” in the case of CDOs), the holders of which were paid only after the claims of all the higher tranches had been met. This tranche was thus the riskiest. If there were defaults on the mortgages or other forms of debt making up the pool of an ABS or

CDO, the holders of the lowest tranche were the first to suffer the consequent loss. Only if losses mounted to such a level that the lowest tranche was entirely wiped out would the holders of the next-lowest tranche suffer a loss. These different levels of risk were compensated in the form of higher interest payments on lower tranches, with the topmost tranche typically paying out only a small “spread” (that is, only a small increment over a benchmark interest rate such as Libor, or London Interbank Offered Rate).

There were various motivations for setting up ABSs and CDOs. ABSs, for example, were initially created mainly as a way of raising capital for mortgage lending, while many of the early CDOs were designed to remove the risks of corporate lending from bank’s balance sheets. However, from the end of the 1990s onward, arbitrage became an increasingly important motivation, first in the case of CDOs (some of which were explicitly called “arbitrage CDOs”) and then for ABSs. The arbitrage was quite simple in conception: investors could be persuaded to buy the tranches of an ABS or CDO in return for payments that were, in aggregate, smaller than the cash flows from the debt in the ABS or CDO pool. If, in such a situation, the constructors of an ABS or a CDO could sell all its tranches to investors, they could capture the difference as risk-free arbitrage profit. What was being arbitrated in this case was directly social in nature: it was the authority of the credit-rating agencies and the way in which their ratings were built in to structures of governance in the financial markets. For example, pension funds in the United States are generally allowed to buy only securities with investment-grade ratings, and money-market funds are often restricted to the highest of those ratings. The capital-adequacy rules governing banking also gave banks themselves increasing incentives to hold securities with the highest ratings.

The way in which the rating agencies evaluated ABSs and CDOs made it possible to create large tranches rated AAA out of pools of debt of lower credit quality. (For the details of the modeling procedures involved, and an account of the empirical research being drawn on here, see MacKenzie 2009b.) This may sound like alchemy (or deliberate wrongdoing by the rating agencies), but was in fact initially perfectly justifiable; even if the chances of default on any individual mortgage or corporate loan were far from tiny, combining those mortgages or loans in a pool meant that likely losses were reasonably predictable and could be absorbed by lower tranches and other forms of protection against default, greatly reducing the probability of the highest tranches incurring a loss. However, the very attractiveness of the consequent arbitrage had the effect of undermining the empirical accuracy of the models used to produce these ratings, at least in the case of mortgages. The capacity to package mortgages into ABSs, and then to package those ABSs into CDOs, greatly reduced incentives for caution in lending, and also made it possible for the volume of that lending to expand considerably, thus setting the scene for the crisis in the US mortgage market that started to become apparent in the second half of 2006 and reached disastrous levels from summer 2007 onwards.

Huge losses for investors in ABSs and CDOs (especially ABS CDOs) were thus created, but perhaps most surprising was the extent to which those losses accumulated within the financial system itself, rather than being passed on to end investors. Especially in the case of ABS CDOs (the category of instrument that did most damage to the financial system), specific features of the arbitrage had the unintended consequence of concentrating rather than distributing losses. Most important were the super-senior tranches of ABS CDOs. As suggested above, those tranches could offer only very modest “spreads” without undermining the profitability of the arbitrage, and the low “spreads” meant that despite their AAA ratings, these tranches were hard to sell to

external investors. Accordingly, banks tended to retain them themselves, frequently keeping the trade apparently riskless by “insuring” those tranches with the specialist bond insurers known as “monolines” or the financial products division of the giant insurer AIG. (Because the risk of loss on these super-senior tranches appeared very low indeed, the cost of purchasing this insurance was less than the spread offered by the senior tranches, so leaving a small arbitrage profit.) However, the giant scale on which the arbitrage was conducted meant that when losses did begin to hit even the AAA tranches of ABS CDOs, those who had insured those tranches against loss were often unable to meet their obligations. The US government had to step in and rescue AIG, and banks were often left with no alternative but to accept much lower payouts from monolines than those to which they were legally entitled.

As noted, the sociality of arbitrage is here most evident in the role of credit ratings. The materiality of prices is also important in the market for ABSs, CDOs, and the “credit default swaps” that “insured” tranches of these products against loss. These instruments are not traded on an organized exchange such as those in Chicago, but directly negotiated between institutions, and the crucial such institutions were a small number (around a dozen) of major international banks, which, for example, acted as “market-makers” in credit default swaps, constantly quoting the prices at which they would “sell” protection against loss and “buy” such protection. The material form that these prices took was e-mail messages to other market participants such as more minor banks and hedge funds. Those messages were tailored to the particular client: large-scale, valued clients were often offered better prices than smaller ones.

Clearly, such practices depended upon keeping control of the circulation of prices, so that less favored clients would not know the better prices being offered to others. However, a specialist firm, CMA, created a system, known as “QuoteVision,” which parsed the incoming e-

mail messages received by all its subscribers, extracted the prices from them, and made those prices available to each subscriber. In response, many of the major market-makers started to send out price quotes in the form of e-mail messages that could not be forwarded to the QuoteVision system. However, CMA has been able to circumvent this by developing a system that electronically “scans” incoming e-mails (even if these are not forwardable), and continues to extract prices from them. The materiality of prices is thus at the heart of a subterranean conflict in this area, between the large market-making banks and their frequently smaller, less prominent clients.

## Conclusion

Our argument in this chapter has been that arbitrage—how it is practiced, its risks, its uncertainties, its limits, and its capacities to weld markets together into a financial system—can properly be understood only if it is grasped in its full materiality and sociality. That kind of rich, qualitative understanding is, of course, different from the more abstract but quantitatively more precise understanding typically sought by economists, even “behavioral finance” specialists. Nevertheless, there are areas of overlap between a “social studies of finance” perspective and financial economists’ investigation of the consequences of relaxing their discipline’s traditional purist definition of arbitrage.

For example, Shleifer and Vishny (1997) model the risk that those who provide arbitrageurs with capital will withdraw it prematurely in the face of temporarily adverse price movements. Brav and Heaton (2002) address what in our terms is the difficulty that arbitrageurs can have convincing themselves and their audiences that a price pattern is indeed a discrepancy that can be the object of arbitrage. In circulating the chart of the price history of the Brazil 14s and 40s, the

trader we observed was seeking to solve in practice the problem modeled by Abreu and Brunnermeier (2002): the limit to arbitrage that can arise when “rational traders face uncertainty about when their peers will exploit a common arbitrage opportunity” (2002: 341). Attari, Mello, and Ruckes (2005) model a risk that became very pertinent for LTCM after the fund’s difficulties became known to others at the start of September 1998, but of which all large arbitrageurs need to be wary: that the combination of capital constraints and positions known to other traders can make arbitrageurs’ actions predictable and exploitable.

Shleifer and Vishny, Brav and Heaton, Abreu and Brunnermeier, and Attari, Mello, and Ruckes put forward four separate models, each capturing one of the aspects that we posit as intrinsic to arbitrage as market practice. No integrated model has yet emerged from the literature in economics on the limits of arbitrage, but our research suggests that it is in the interaction of arbitrage’s aspects that its crucial limits may reside. Thus the crisis surrounding LTCM arose from the way in which the process of capital withdrawal modeled by Shleifer and Vishny interacted with the consequences of others imitating a single prominent arbitrageur, and LTCM’s crisis was worsened (to a degree that is hard to determine) by other traders “arbitraging the arbitrageur” in the manner modeled by Attari, Mello, and Ruckes.

We would therefore be hopeful that the study of arbitrage could be a productive area of collaboration between financial economists and those in the wider social sciences prepared to tackle financial markets in their full materiality and sociality. We are, in addition, certain that arbitrage is a pivotal topic for the sociology of finance. The details of arbitrage may seem to be little things, but they are little things connected to big issues such as the credit crisis. The powers and limits of arbitrage are critical to global financial markets, and the material sociology we advocate is needed to understand them.



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<sup>1</sup> Earlier versions of this chapter appeared as Beunza, Hardie, and MacKenzie (2006) and MacKenzie (2009a: ch. 5). Revision for this volume was supported by a grant from the UK Economic and Social Research Council (RES-062-23-1958). We thank Daniel Beunza warmly for his contribution to the original version.

<sup>2</sup> Our research on the hedge fund is described in detail in Hardie and MacKenzie (2007).